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(54) **INTELLIGENT WATERING PUMP**

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G05B 19/042 (2006.01)

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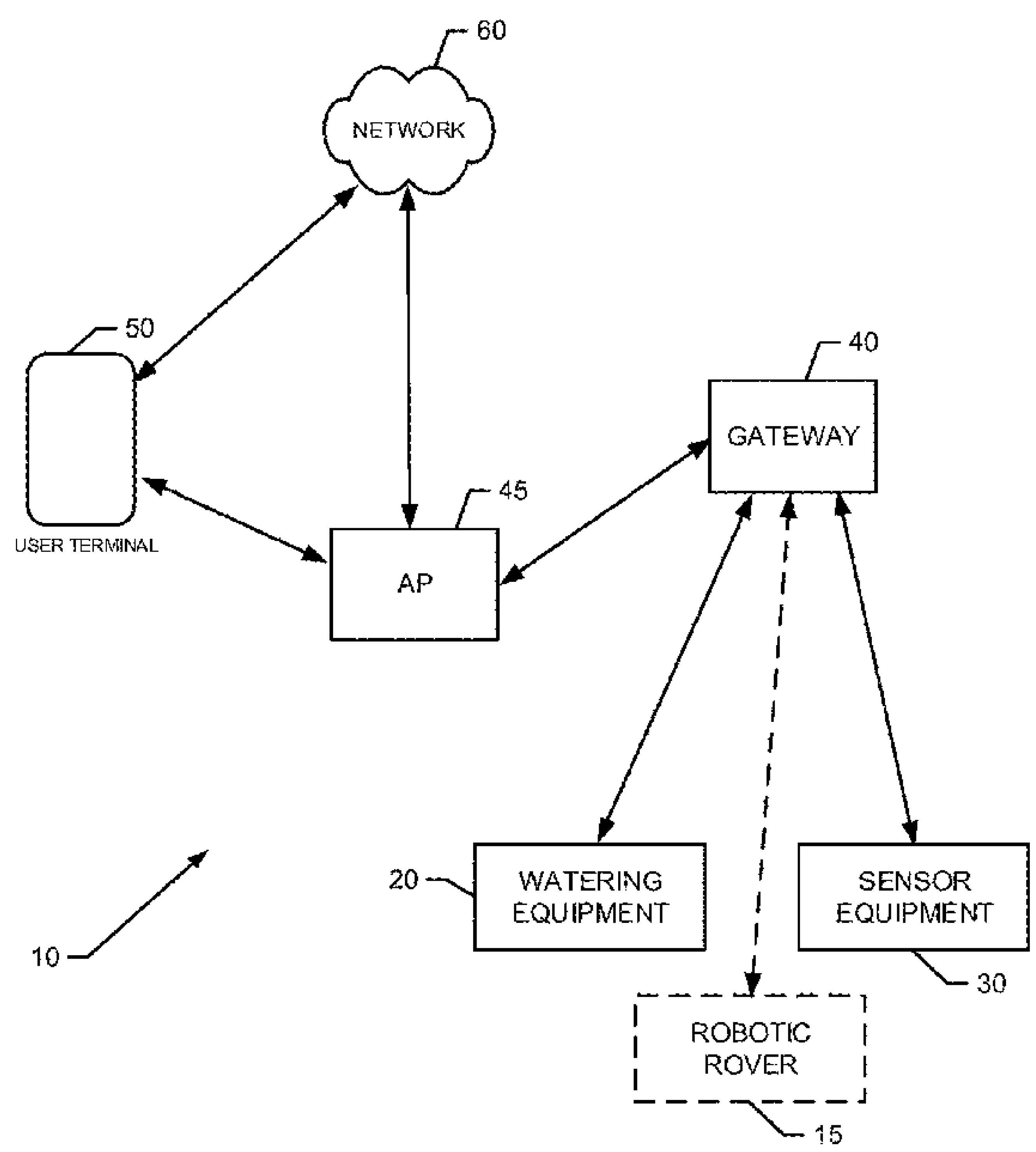
(57) **ABSTRACT**

A system with sensor equipment including one or more sensors and watering equipment disposed on a parcel of land and configured to selectively apply water to the parcel, and a gateway configured to provide for communication with the sensor equipment and the watering equipment. The watering equipment comprises a watering pump, wherein the watering pump is operably coupled to a water source and a water line to alternately couple the water source to and isolate the water source from the water line. The watering pump further includes a pump sensor assembly configured to direct the watering pump based on detected environmental and operational parameters.

20 Claims, 7 Drawing Sheets



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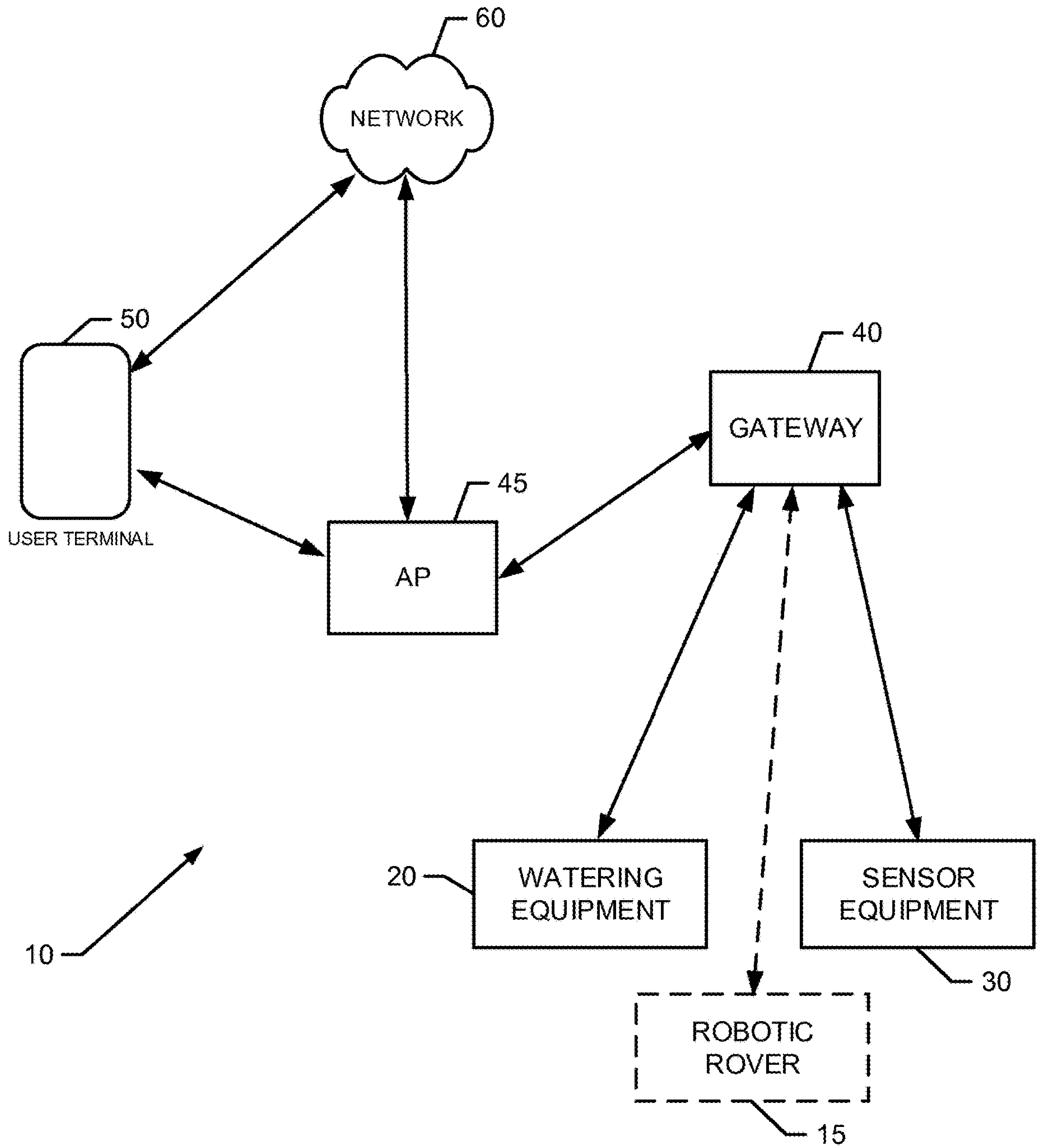
60
NETWORK
50
USER TERMINAL
40
GATEWAY
45
AP
20
WATERING EQUIPMENT
SENSOR EQUIPMENT
30
ROBOTIC ROVER
15
10

FIG. 1.

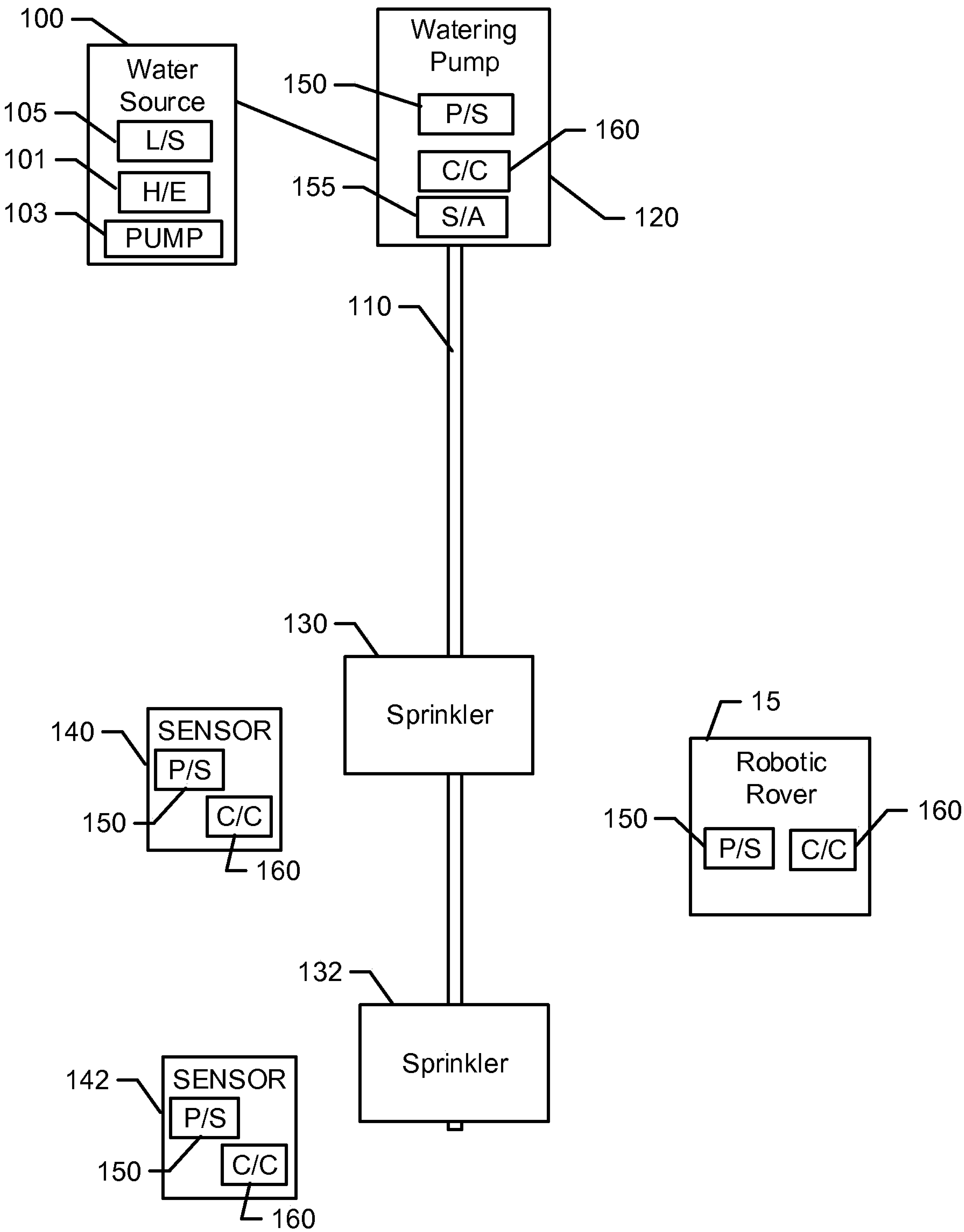
100
Water Source
105
L/S
101
H/E
103
PUMP
Watering Pump
150
P/S
C/C
160
155
S/A
120
110
130
Sprinkler
140
SENSOR
P/S
150
C/C
160
15
Robotic Rover
150
P/S
C/C
160
132
Sprinkler
142
SENSOR
P/S
150
C/C
160

FIG. 2.

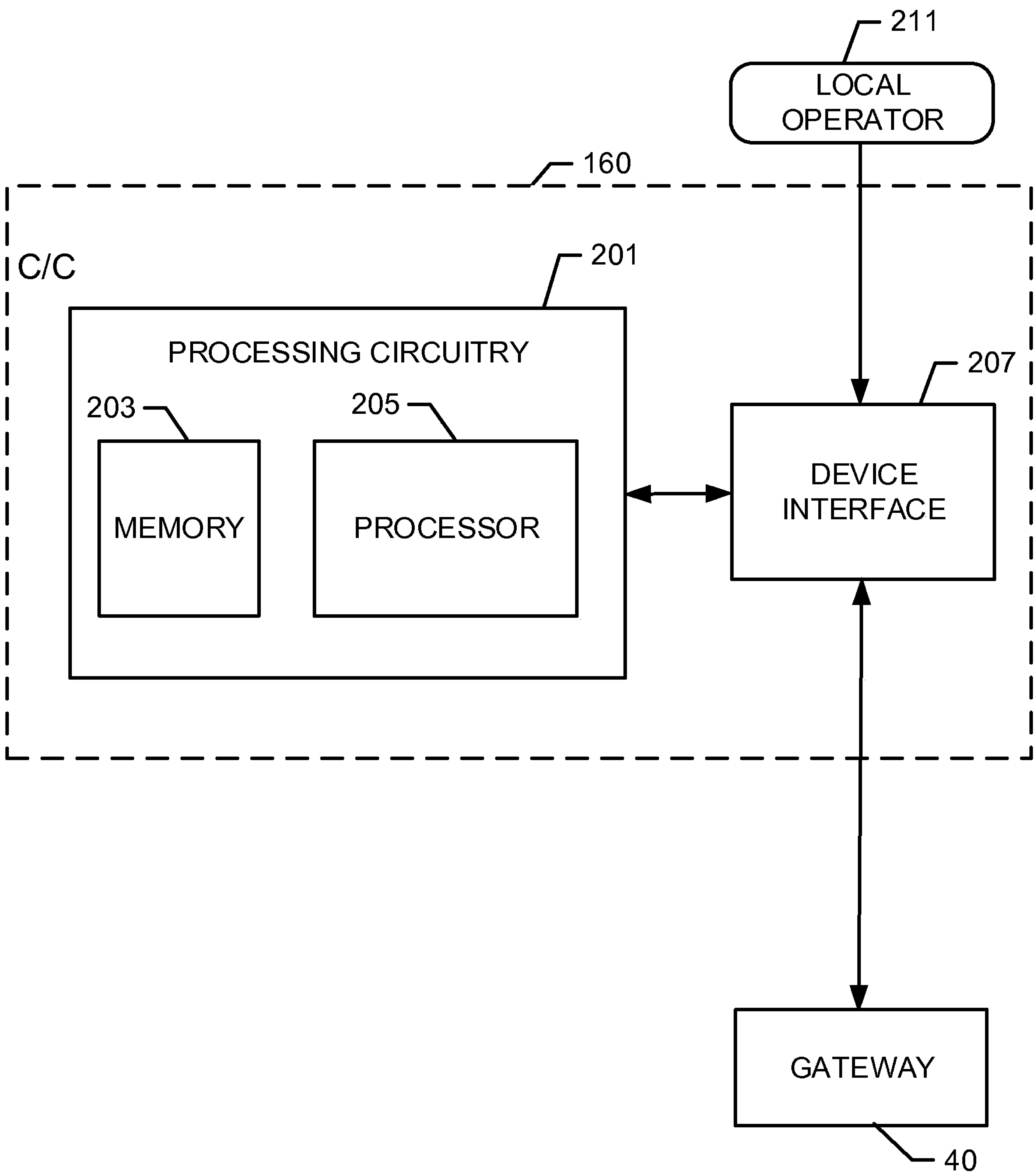
211
LOCAL OPERATOR
160
C/C
201
PROCESSING CIRCUITRY
203
MEMORY
205
PROCESSOR
207
DEVICE INTERFACE
GATEWAY
40

FIG. 3.

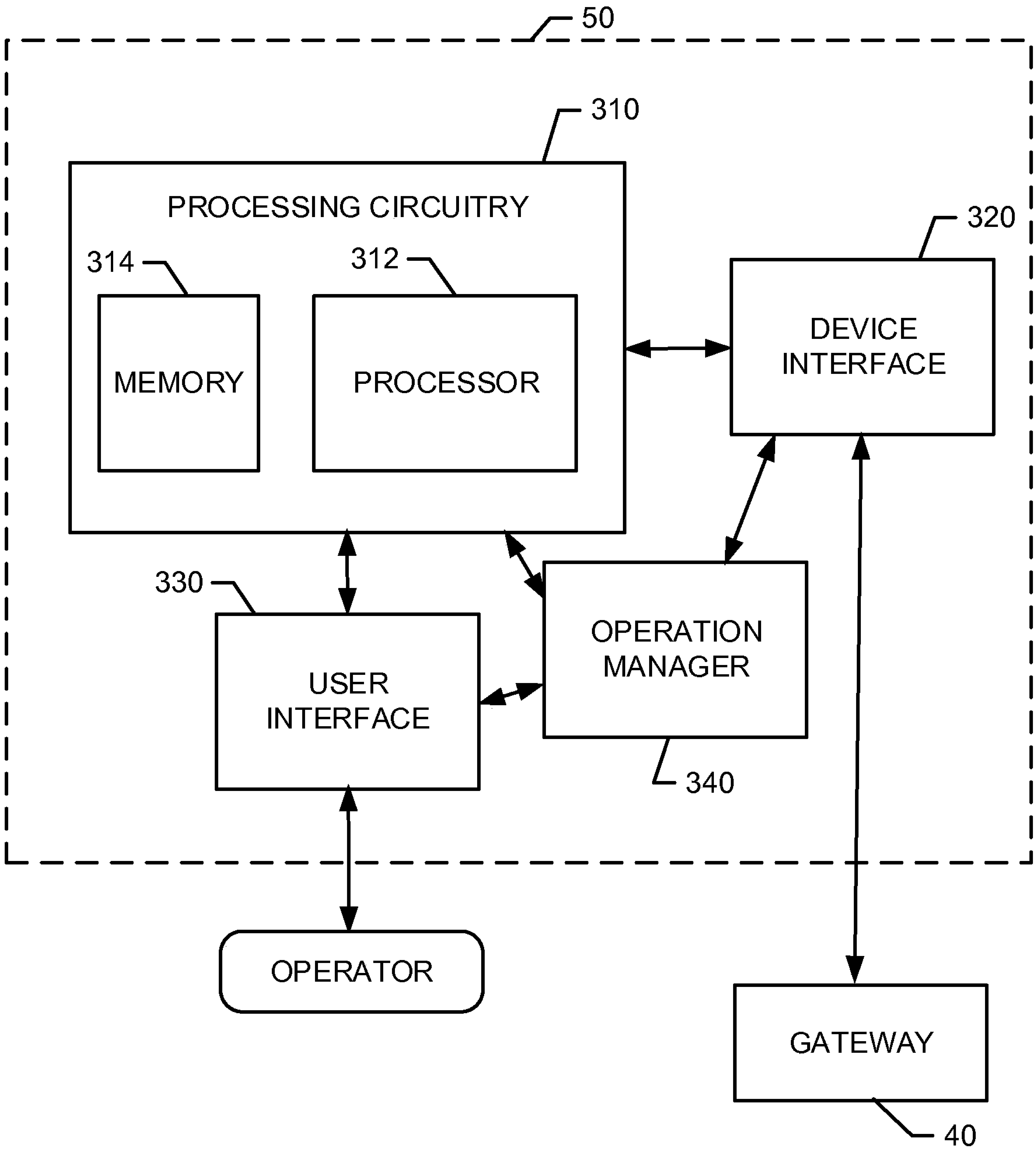
50
310
PROCESSING CIRCUITRY
314
312
MEMORY
PROCESSOR
320
DEVICE
INTERFACE
330
USER
INTERFACE
OPERATION
MANAGER
340
OPERATOR
GATEWAY
40

FIG. 4.

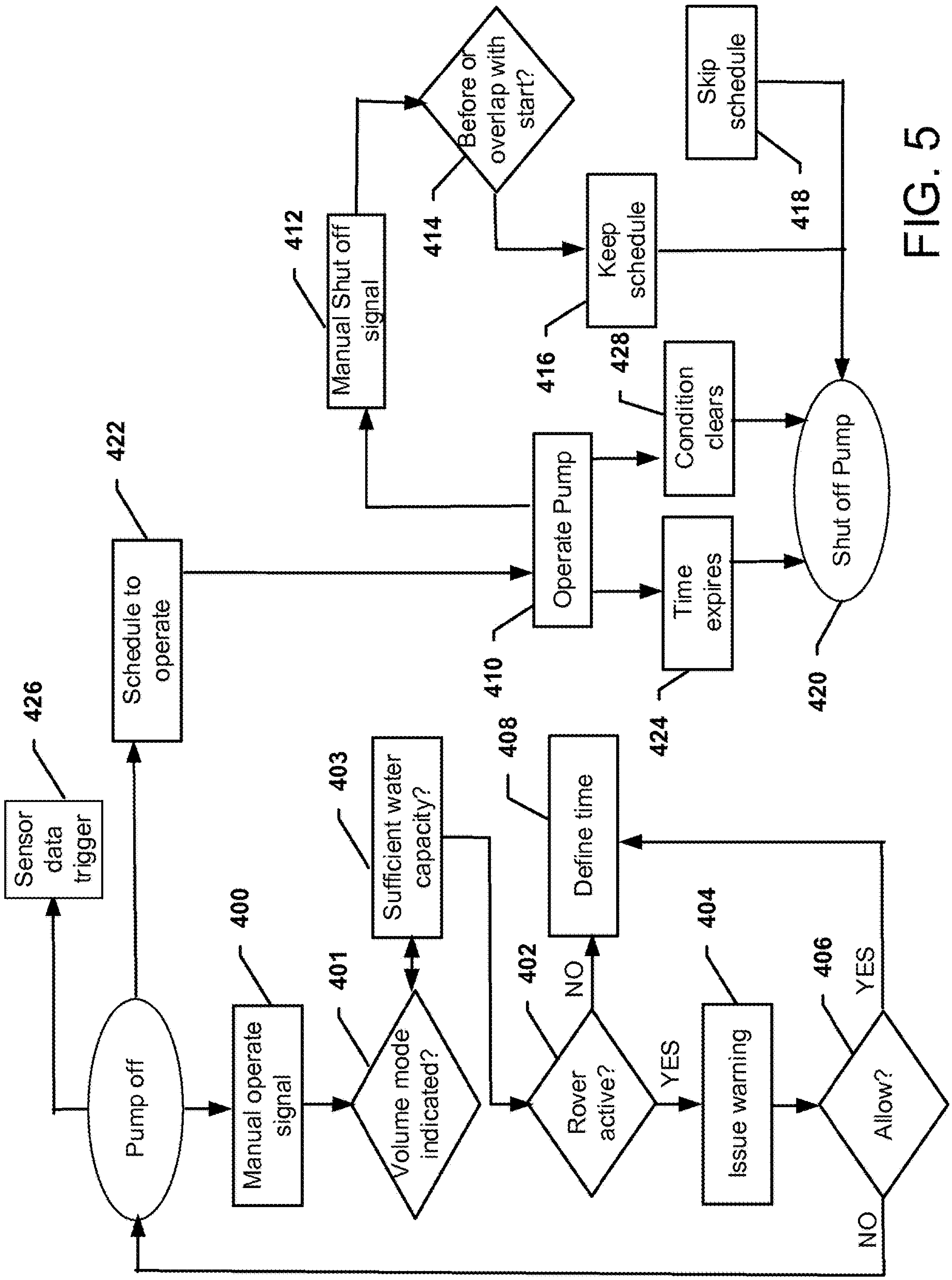
Pump off
426
Sensor data trigger
Schedule to operate
422
400
Manual operate signal
401
Volume mode indicated?
403
Sufficient water capacity?
402
Rover active?
NO
YES
408
Define time
404
Issue warning
406
Allow?
YES
NO
410
Operate Pump
412
Manual Shut off signal
414
Before or overlap with start?
416
Keep schedule
418
Skip schedule
428
Condition clears
424
Time expires
420
Shut off Pump

FIG. 5

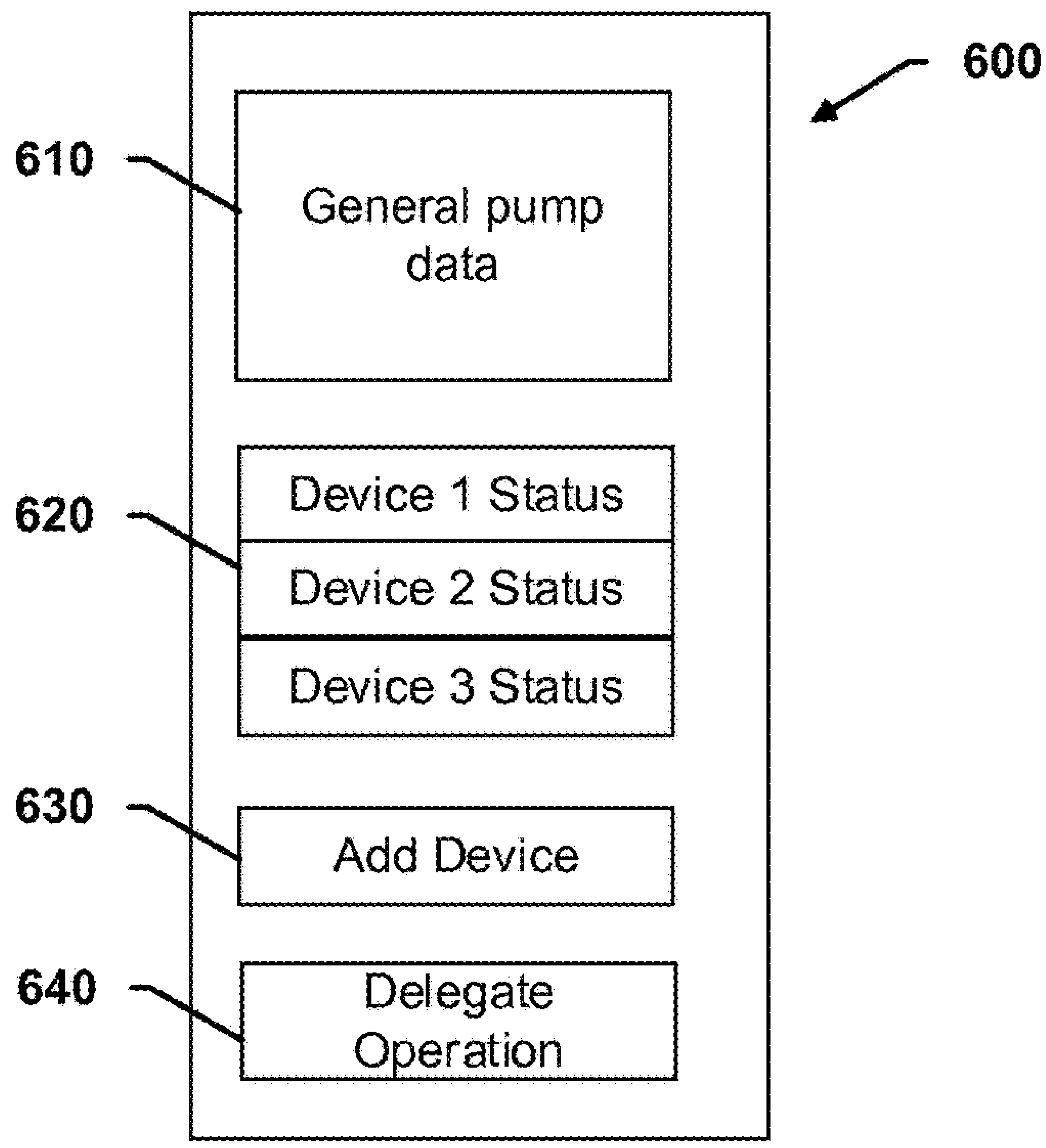
600
610
General pump data
620
Device 1 Status
Device 2 Status
Device 3 Status
630
Add Device
640
Delegate Operation

FIG. 6A

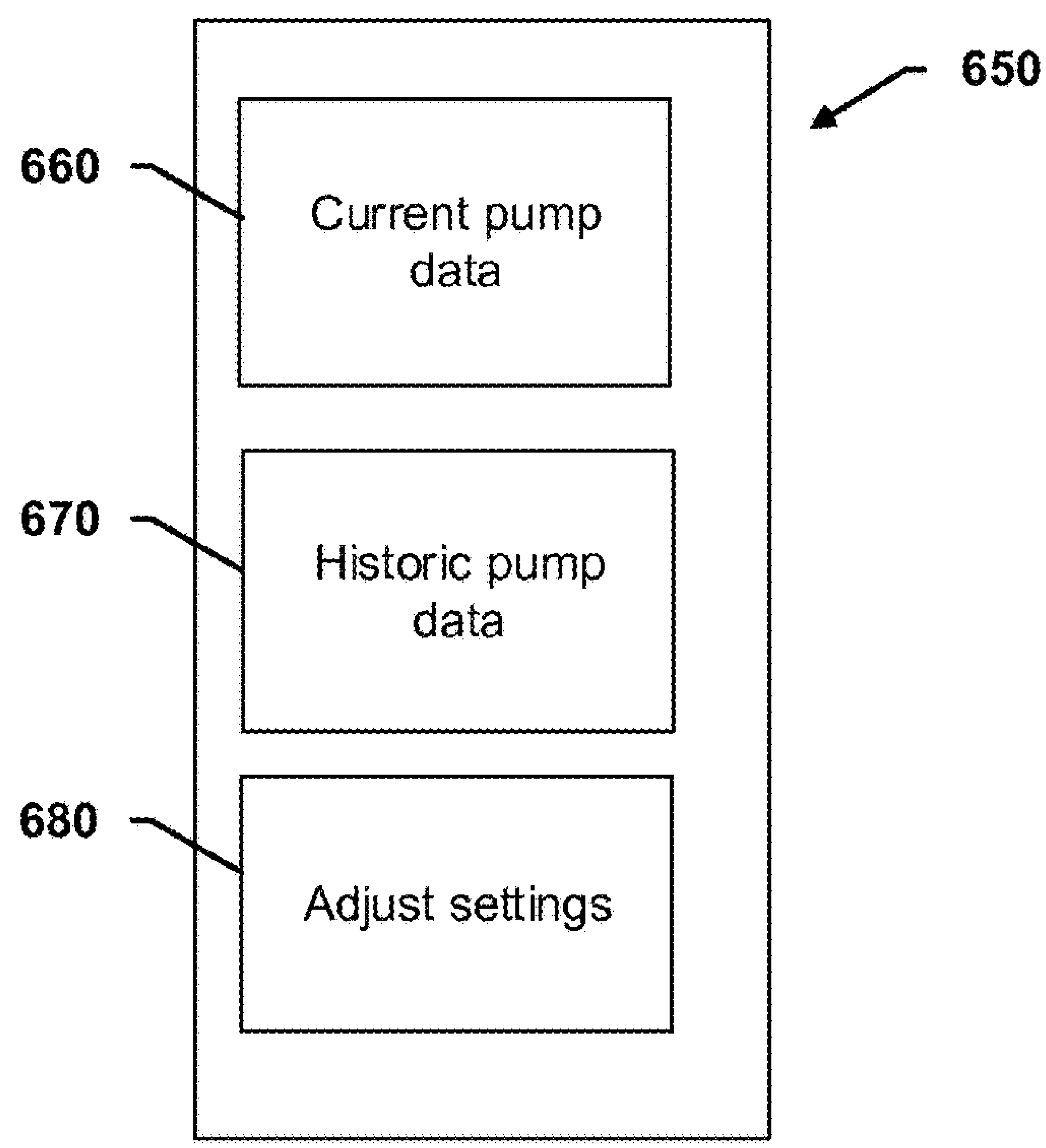
650
660
Current pump data
670
Historic pump data
680
Adjust settings

FIG. 6B

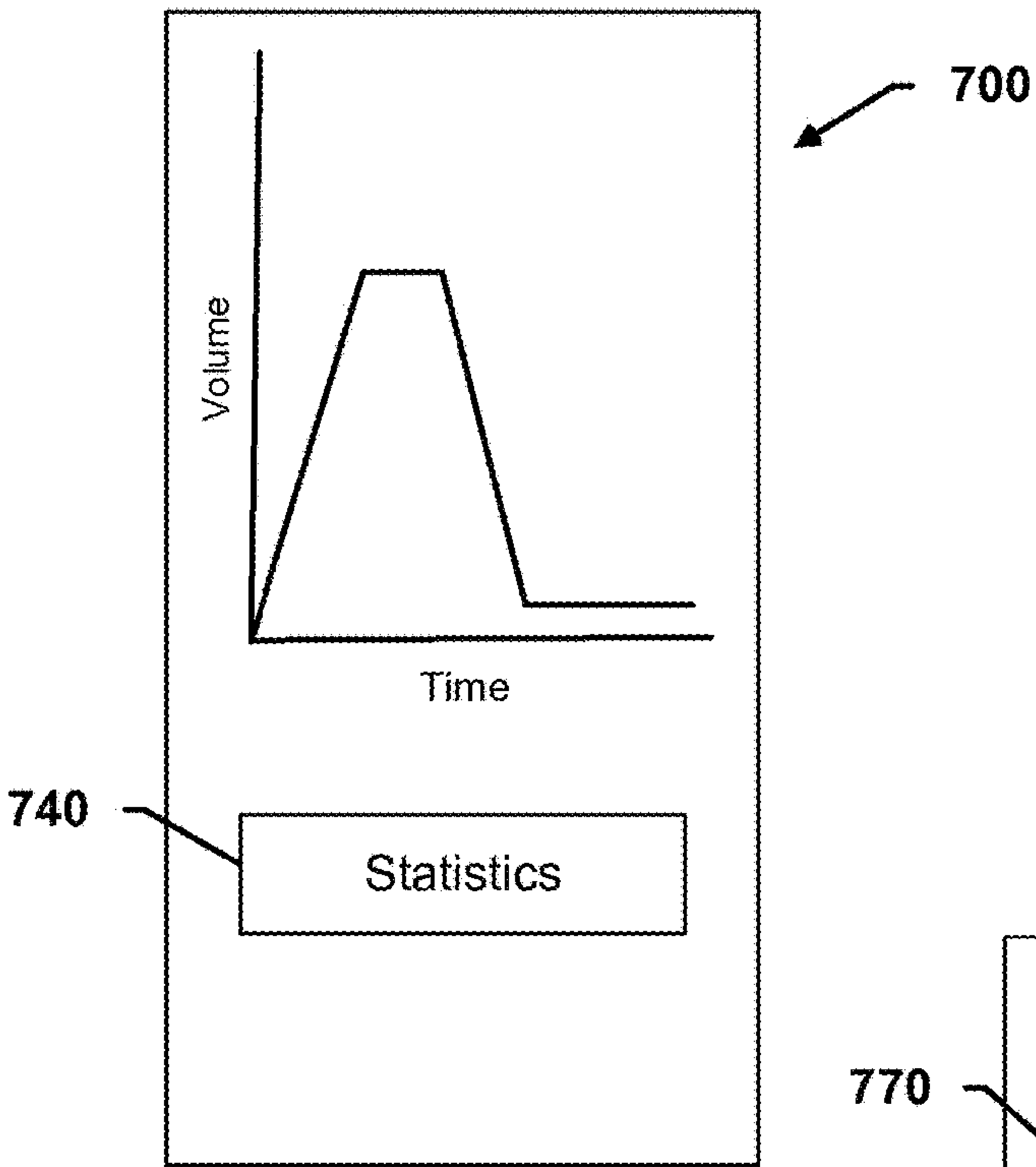
700
Volume
Time
740
Statistics

FIG. 6C

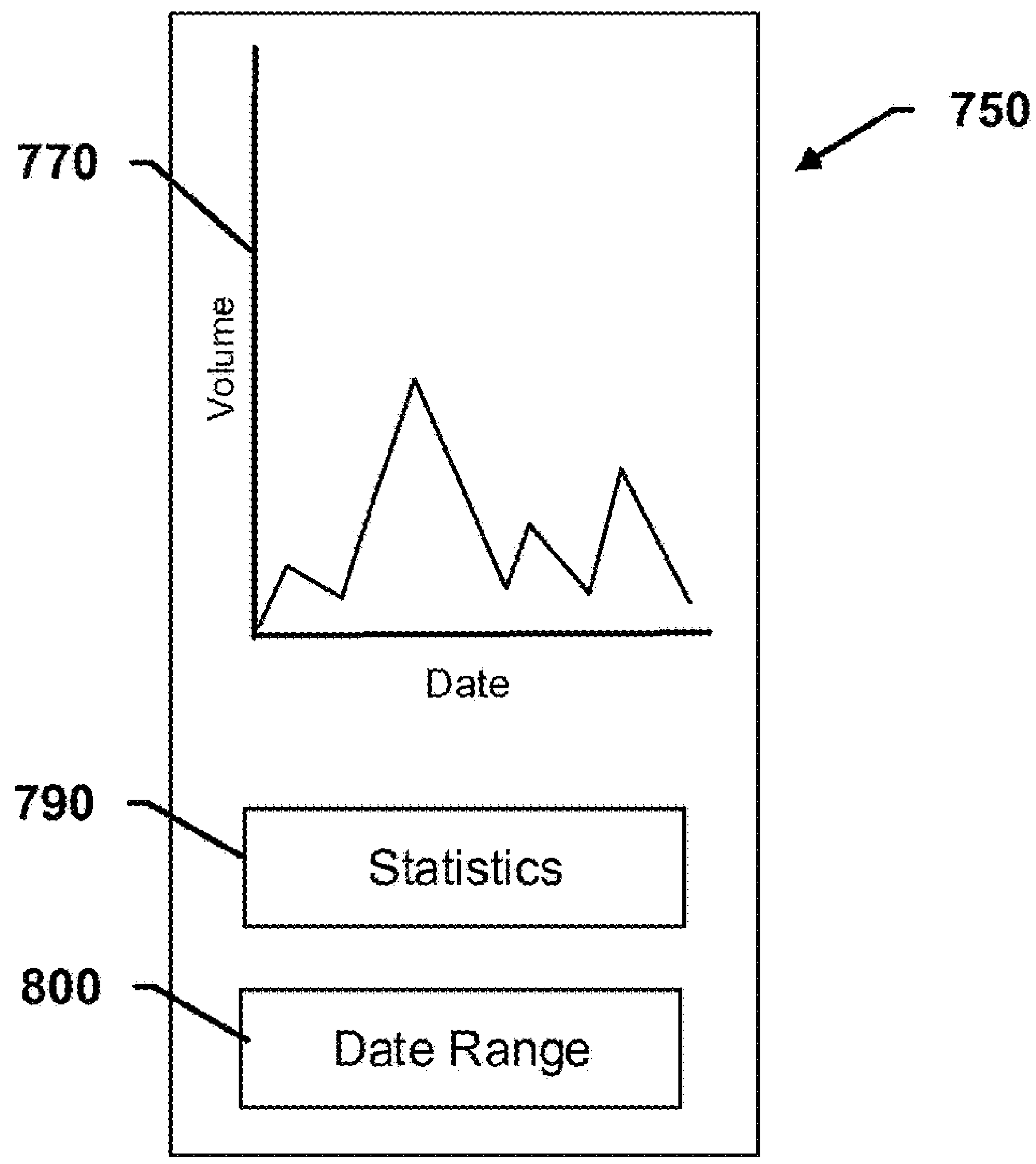
750
770
Volume
Date
790
Statistics
800
Date Range

FIG. 6D

INTELLIGENT WATERING PUMP

TECHNICAL FIELD

Example embodiments generally relate to intelligent systems and, more particularly, relate to a system for intelligent watering that includes components configured to facilitate easy interface and operation.

BACKGROUND

Grounds care maintenance tasks may include lawn care and/or gardening tasks related to facilitating growth and manicuring the lawns or gardens that hopefully prosper as a result of those efforts. Facilitating growth has commonly required individuals to focus routine attention on ensuring growing conditions are appropriate for the vegetation being grown, and on providing the necessary care and grooming tasks to further enhance growth.

As technological capabilities have improved, various devices or sensors have been developed that are capable of employment to monitor various aspects of growing conditions. Gardeners have therefore been enabled to employ the sensors or devices in specific locations to monitor and correct, if needed, the growing conditions. However, even with the improvement of monitoring devices or sensors, gardeners are still often required to employ a high degree of manual interaction to place and/or operate the devices or sensors.

BRIEF SUMMARY OF SOME EXAMPLES

Some example embodiments may therefore provide a capability for intelligent control or management of a number of assets in connection with yard maintenance with the assistance or inclusion of a user terminal. Thus, for example, sensor equipment and watering equipment operation (with or without a robotic rover) may be coordinated remotely for efficient gardening and lawn care using a smart watering pump.

In an example embodiment, a system for intelligent control or management of a number of assets in connection with yard maintenance is provided. The system may include sensor equipment including one or more sensors disposed on a parcel of land, watering equipment disposed on the parcel and configured to selectively apply water to the parcel, and a gateway configured to provide for communication with the sensor equipment and the watering equipment. The watering equipment may include a watering pump, the watering pump being operably coupled to a water source and a water line to alternately couple the water source to and isolate the water source from the water line. The watering pump may further include a pump sensor assembly configured to detect environmental and operational parameters and processing circuitry configured to operate the watering pump based on detected environmental and operational parameters.

In another example embodiment, a watering pump for intelligent control or management of yard maintenance is provided. The watering pump may be operably coupled to a water source and a water line to alternately couple the water source to and isolate the water source from the water line. The watering pump may further include a pump sensor assembly configured to detect environmental and operational parameters and processing circuitry configured to operate the watering pump based on detected environmental and operational parameters.

Some example embodiments may improve the ability of operators to maximize the beauty and productivity of their yards and gardens, but do so in a user friendly and intuitive way.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

Having thus described the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

FIG. **1** illustrates a block diagram of a system in accordance with an example embodiment;

FIG. **2** illustrates a block diagram of deployed components of the system according to an example embodiment;

FIG. **3** illustrates a block diagram of processing circuitry that may be employed in the deployed components according to an example embodiment;

FIG. **4** illustrates a block diagram of processing circuitry that may be employed in a user terminal according to an example embodiment;

FIG. **5** illustrates a flow diagram of various operations associated with control of a watering pump in accordance with an example embodiment; and

FIG. **6**, which includes FIGS. **6**A, **6**B, **6**C, and **6**D, illustrates example interface consoles or screens that may be generated at the user terminal according to an example embodiment.

DETAILED DESCRIPTION

Some example embodiments now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all example embodiments are shown. Indeed, the examples described and pictured herein should not be construed as being limiting as to the scope, applicability or configuration of the present disclosure. Rather, these example embodiments are provided so that this disclosure will satisfy applicable legal requirements. Like reference numerals refer to like elements throughout. Furthermore, as used herein, the term “or” is to be interpreted as a logical operator that results in true whenever one or more of its operands are true. Additionally, the term “yard maintenance” is meant to relate to any outdoor grounds improvement or maintenance related activity and need not specifically apply to activities directly tied to grass, turf or sod care. Thus, yard maintenance should be appreciated to encompass gardening, lawn care, combinations thereof, and/or the like. As used herein, operable coupling should be understood to relate to direct or indirect connection that, in either case, enables functional interconnection of components that are operably coupled to each other.

Example embodiments may provide an intelligent system for monitoring and/or maintaining yard conditions (i.e., lawn and/or garden conditions) at any of what may potentially be a number of locations throughout a particular parcel, and allowing the operator to interface with devices within the system in a flexible way. Moreover, the devices of the system may be coordinated in their activities and/or may be configured to adapt to their environment or at least to the current conditions or stimuli that are present in their environment. In some cases, the operations conducted and/or monitoring may be accomplished with the assistance of an intelligent watering pump. In this regard, for example, the intelligent watering pump may utilize a pump sensor assembly, a communication network that gathers information on growing conditions from sensor equipment for association of the information with the areas from which the information was gathered, and a network of other users in order to provide intelligent and efficient watering of a parcel of land. Therefore, the watering pump may be employed in a system that includes an interface mechanism to enable the operator to have a great deal of flexibility with remotely controlling various components of the system and programming such components via processing circuitry at each respective component. Programming may therefore be coordinated remotely, but at least some of the programming may also be stored locally so that the system can operate with or without connectivity. In some cases, the connectivity aspects of the system may utilize home network components and wide area network components (e.g., the internet), but may also include a gateway that is configured to interface between the deployed components (e.g., components in the yard/garden or otherwise related to yard maintenance) and the home network/wide area network components. As mentioned above, the processing aspects may be distributed between local and remote management components so that some aspects of yard maintenance may utilize remote assets or at least incorporate information available from abroad, while other aspects can be managed locally. In any case, adaptability and ease of interface and control are characteristics of the system that are improved by employing example embodiments.

The system may therefore employ any combination of fixed and/or mobile assets that gather data that relates to specific segments of the parcel that may correspond to respective different areas. In particular, the system may employ an intelligent watering pump that is configured to be programmed for servicing one or more such specific segments. The specific segments may have different types of plants therein, and therefore may optimally have different growing conditions desirable in connection with each respective one of the segments. The owner/operator may program operating instructions to guide the deployed components (including the intelligent watering pump) relative to operations in one or more of the specific segments, which may be referred to as "zones." In some cases, the processing circuitry may be equipped to allow the user to define specific operating parameters and the system may then adapt to the current conditions to operate according to the operating parameters. Given that internet connectivity is possible, in some cases, the system may be employed to correlate desirable growing conditions to an identified plant species based on stored information associated with each plant species from a database or online resource. Accordingly, each zone may have corresponding growing condition parameters associated therewith, and the user can see the growing condition parameters relative to the various areas and program operation of system components accordingly relative to maintaining desired growing conditions (e.g., any or all of moisture level, temperature, lighting level, pH, and/or the like) for the corresponding zone. In some cases, schedules among deployed components may be deconflicted or otherwise organized to prevent damage to components, ineffective use of resources, or efficiency reducing behaviors. The deployed components associated with the zones may provide the operator with reports and/or warnings via the gateway to enable the operator to intercede in certain situations, or the components may simply respond and inform the operator of their responses via the gateway.

FIG. **1** illustrates a block diagram of a system **10** that may be employed to accomplish the basic operations described above in accordance with an example embodiment. Within the context of FIG. **1**, it should be appreciated that certain tasks, like grass cutting, chemical application, visual monitoring and/or the like may be performed by a robot or robotic rover **15**. Because the system could operate without the robotic rover **15**, the robotic rover **15** is shown in dashed lines in FIG. **1**. Robots or other devices could also be engaged to perform certain other yard maintenance tasks such as raking, fertilizing, lighting, wildlife dispersion and/or the like.

Other tasks, like lawn watering, may be performed by sprinkler/irrigation heads and/or a watering pump that interfaces therewith. The sprinkler/irrigation heads may be attached to hoses and the watering pump may provide a mechanism by which to control the turning on/off of water application at the respective sprinkler/irrigation head locations by providing a central intelligently controllable source for providing water to the sprinkler/irrigation heads and/or the hoses. The hoses, sprinkler/irrigation heads, and/or watering pump may together form watering equipment **20**.

Meanwhile, various sensors may be employed by insertion of such sensors into soil for monitoring soil or other growing conditions (e.g., lighting levels, moisture levels, pH, temperature, video or image data, etc.). These sensors may therefore be understood to take various forms within the system **10**. However, generally speaking, the sensors may have connectivity to the system **10** in order to enhance operation of system components on the basis of the soil and/or growing condition information gathered by the sensors. Regardless of the specific configuration or placement paradigm, the various sensors may represent sensor equipment **30**, as described above.

The sensor equipment **30**, and in some cases also one or more of the devices that comprise the watering equipment **20**, may be in communication with a gateway **40** via wired or wireless connections. The gateway **40** may subsequently have wired or wireless connection to an access point (AP) **45**, which may be directly or indirectly connectable to a user terminal **50**. The AP **45** may be a router of a home network of the operator. In some cases, direct connection of the AP **45** to the user terminal **50** may be provided via short range wireless communication methods (e.g., Bluetooth, WiFi and/or the like). Indirect connection of the AP **45** to the user terminal **50** may occur via a network **60**. The network **60** may be a data network, such as a local area network (LAN), a metropolitan area network (MAN), a wide area network (WAN) (e.g., the internet), a wireless personal area network (WPAN), and/or the like, which may couple devices (e.g., the deployed components) to devices such as processing elements (e.g., personal computers, server computers or the like) and/or databases such as the user terminal **50**. Communication between the network **60** and other devices of the system **10** may be accomplished by either wireline or wireless communication mechanisms and corresponding communication protocols. As such, for example, some or all of the sensors of the sensor equipment **30**, the watering equipment **20** and/or the robotic rover **15**, may be connected to the user terminal **50** by wire and/or be wireless communication means.

It should also be appreciated that although the robotic rover **15** is illustrated separately in FIG. **1**, the robotic rover **15** may act as one or both of a piece of sensor equipment **30** or a piece of watering equipment **20**. However, given the ability of the robotic rover **15** to act as either or both of a piece of sensor equipment **30** or a piece of watering equipment **20** and the ability of the robotic rover **15** to perform other tasks (e.g., grass cutting) in combination with or independent of the sensor equipment **30** and the watering equipment **20**, the robotic rover **15** is shown separately in FIG. **1**.

The gateway **40** may be a translation agent configured to interface with any or all of the deployed components via wired or wireless communication. In some embodiments, the gateway **40** may include a high performance antenna to enable the gateway **40** to communicate wirelessly with deployed components via an 868 mHz radio link (e.g., a first wireless link). However, other radio links may be employed in other cases. The first wireless link, and the components connected thereby, may be part of a first network (e.g., a garden network) or deployed component network that extends outdoors. Components internal to the house or business, and extending to and between the user terminal **50** may form a second network. As such, the gateway **40** may be a translation agent between the first and second networks. The gateway **40** may be an aggregation point and communications center for communications in both networks.

As such, the gateway **40** may be provided within the home or otherwise indoor environment of the operator, and still wirelessly communicate with the deployed components (via the first wireless link) to translate instructions thereto from the operator, which may be provided via a second wireless link to the AP **45**. In an example embodiment, the wireless communications may be secured by employing encryption or other security techniques. The gateway **40** may also provide secure cloud data storage through connection to the network **60** (e.g., via the AP **45**). In some examples, the first and second wireless links may be different wireless links that employ different communication protocols and/or frequencies.

The gateway **40** may also provide the ability for each of the deployed components to be monitored, controlled, programmed, or otherwise interfaced with by an operator using the user terminal **50**. In particular, in some cases, the user terminal **50** may be configured to execute an application (or app) that is tailored to providing an easy setup and/or easy to use interface for interaction with the gateway **40** (and the corresponding deployed components that are reachable through the gateway **40**). The user terminal **50** may therefore be a smartphone or other mobile terminal, or a laptop, PC, or other computing/communication device. As such, the user terminal **50** may include processing circuitry that is enabled to interface with corresponding processing circuitry of the gateway **40** and/or the deployed components to program, control or otherwise interact with the deployed components in a manner described in greater detail below.

The interaction between the user terminal **50** and the gateway **40** to facilitate programming of, control of, or interaction with the deployed components may create an interactive and fully connectable garden system for irrigation or mowing control/coordination. The app that may be executed at the user terminal **50** may be configured for control of any or all of the deployed components on a real time or programmed basis. The resulting system may be a holistic and connected automatic garden system. Moreover, the connection to content on the internet via network **60** may allow educational content to be integrated into the system's operation to provide operators with an improved interface and more control over gaining full satisfaction of their gardening experience. For example, the educational content may include videos that example how to start, program, or troubleshoot any operations regarding the components of the water equipment **20**. In an example embodiment, the app may be used to program at least some of the watering equipment **20** to operate on a locally stored watering schedule in a first mode and operate as an autonomous pressure pump in a second mode of operation.

FIG. **2** illustrates a water migration path that may be practiced in connection with an example embodiment. However, it should be appreciated that some of the components may be removed in simpler example embodiments, and some components may be added to provide more complex architectures in other example embodiments. Thus, the example of FIG. **2** is not provided to be limiting in relation to the components included in the system, but merely to show an example of some components that may be included in one example system. Moreover, it should be appreciated that although FIG. **2** shows a single water delivery line, other embodiments can employ multiple water delivery lines to service a parcel or yard. Thus, example embodiments may be practiced with any number of lines, and with separate and/or different water sources.

Referring now to FIG. **2**, a water source **100** may be used to charge a water line **110** via a watering pump **120**. In some example embodiments, the water source **100** may include a heating element **101** for heating the water in the watering source **100**. Even further, the water source **100** may contain a level sensor **105** for detecting the water level in the water source **100**. In some cases, the water source **100** may also charge a second water line via a second watering pump, or via the watering pump **120**. The water line **110** may be a flexible water hose or garden hose. The watering pump **120** may be one of the deployed components that forms one component of the watering equipment **20** of FIG. **1**. The watering pump **120** may be operably coupled to the water source **100** such that the water source **100** is a pressurized water supply for the water line **110** when the watering pump **120** is operational. However, when the watering pump **120** is not operational, the water line **110** may be substantially depressurized, or at least only have residual pressure remaining from the last operation of the watering pump **120**. Thus, it should be understood that the water source **100** is not a typical pressurized water supply of a house or other structure. Instead, the water source **100** may typically be an otherwise unpressurized water source, such as a reservoir or cistern.

In an example embodiment, one or more sprinklers (e.g., a first sprinkler **130** and a second sprinkler **132**) may receive water from the water line **110**. The water line **110** may be selectively charged under control of the watering pump **120** to provide water for spraying from the first and second sprinklers **130** and **132**. Likewise, if used, the second water line may be selectively charged under control of the watering pump **120**, or a second watering pump, to provide water for spraying from any additional sprinklers associated with the second water line. When the water line **110** is charged, the first and second sprinklers **130** and **132** may be provided with pressurized water that is distributed therethough responsive to operation of the watering pump **120**. The first and second sprinklers **130** and **132** may typically be components that are not provided with any local intelligence. Instead, the first and second sprinklers **130** and **132** may only be controllable via operation of the watering pump **120** to turn on and off watering functions. However, it is possible that the first and second sprinklers **130** and **132** could have intelligent components and/or control aspects provided therein in some cases.

One or more sensors (e.g., first sensor **140** and second sensor **142**) may also be provided at various locations in the parcel that is served by the sprinklers to detect or sense conditions proximate to the corresponding sensors. The first and second sensors **140** and **142** may each correspond to a respective one of the first and second sprinklers **130** and **132**, and the app at the user terminal **50** may be configured to note such correspondence so that information received from a respective one of the first or second sensor **140** or **142** can be correlated to actions that may be ordered to the watering pump **120**, if needed, based on the information.

In some examples, some of the deployed components may include a power supply (P/S) **150** that is local to the corresponding ones of the deployed components. The P/S **150** of each component may be a battery or battery pack, or mains power. Each powered one of the deployed components may also include communication circuitry (C/C) **160** that includes processing circuitry for controlling each respective component and an antenna for enabling the deployed components to communicate with the gateway **40** via the first wireless link (or alternatively via a wired connection). The robotic rover **15** (if employed) may also be an example of the deployed components, and thus the robotic rover **15** may also include the P/S **150** and the C/C **160**. However, it should be appreciated that the various power supply and communication circuitry components may have different scale, structure and configuration features.

The watering pump **120** may generally operate under the control of the C/C **160** to respectively isolate and operably couple the water source **100** from/to the water line **110**. The watering pump **120** may operate based on operational and volume mode instructions received through the gateway **40** or based on operational and volume information stored or otherwise accessible via the C/C **160** of the watering pump **120**. The watering pump **120** may provide convenience to operation of the system **10** since the watering pump **120** can be controlled from anywhere and/or at anytime via the app at the user terminal **50**, or via locally stored programming instructions, by selecting or executing the desired/programmed operational and volume mode, as described in greater detail below.

In an example embodiment, the C/C **160** may include processing circuitry **201**, as shown in FIG. **3**. The processing circuitry **201** that may be configured to perform data processing, control function execution, and/or other processing and management services according to an example embodiment of the present invention. In some embodiments, the processing circuitry **201** may be embodied as a chip or chip set. In other words, the processing circuitry **201** may comprise one or more physical packages (e.g., chips) including materials, components and/or wires on a structural assembly (e.g., a baseboard). The structural assembly may provide physical strength, conservation of size, and/or limitation of electrical interaction for component circuitry included thereon. The processing circuitry **201** may therefore, in some cases, be configured to implement an embodiment of the present invention on a single chip or as a single "system on a chip." As such, in some cases, a chip or chipset may constitute means for performing one or more operations for providing the functionalities described herein.

In an example embodiment, the processing circuitry **201** may include one or more instances of a processor **205** and memory **203** that may be in communication with or otherwise control a device interface **207**. As such, the processing circuitry **201** may be embodied as a circuit chip (e.g., an integrated circuit chip) configured (e.g., with hardware, software or a combination of hardware and software) to perform operations described herein. In some embodiments, the processing circuitry **201** may communicate with internal electronic components of the watering pump **120**, the first or second sensors **140** and **142** and/or the robotic rover **15**, and enable communication externally with other components.

The device interface **207** may include one or more interface mechanisms for enabling communication with other devices via the gateway **40**. In some cases, the device interface **207** may be any means such as a device or circuitry embodied in either hardware, or a combination of hardware and software that is configured to receive and/or transmit data from/to the gateway **40** by virtue of the device interface **207** being capable of sending and receiving messages via the gateway **40**. In some example embodiments, the device interface **207** may provide interfaces for communication of components of or external to the system **10** via the gateway **40**. If the C/C **160** is for a sensor, the device interface **207** may further interface with a sensor (e.g., a temperature sensor, a pH sensor, a light sensor, a moisture sensor and/or the like) to obtain sensor data for communication to other devices (e.g., watering pump(s)). Meanwhile, if the C/C **160** is for a watering pump **120**, the device interface **207** may provide interfaces to other onboard components (e.g., a user interface including lights and a main button as described below).

The processor **205** may be embodied in a number of different ways. For example, the processor **205** may be embodied as various processing means such as one or more of a microprocessor or other processing element, a coprocessor, a controller or various other computing or processing devices including integrated circuits such as, for example, an ASIC (application specific integrated circuit), an FPGA (field programmable gate array), or the like. In an example embodiment, the processor **205** may be configured to execute instructions stored in the memory **203** or otherwise accessible to the processor **205**. As such, whether configured by hardware or by a combination of hardware and software, the processor **205** may represent an entity (e.g., physically embodied in circuitry—in the form of processing circuitry **201**) capable of performing operations according to embodiments of the present invention while configured accordingly. Thus, for example, when the processor **205** is embodied as an ASIC, FPGA or the like, the processor **205** may be specifically configured hardware for conducting the operations described herein. Alternatively, as another example, when the processor **205** is embodied as an executor of software instructions, the instructions may specifically configure the processor **205** to perform the operations described herein.

In an example embodiment, the processor **205** (or the processing circuitry **201**) may be embodied as, include or otherwise control the C/C **160**. As such, in some embodiments, the processor **205** (or the processing circuitry **201**) may be said to cause each of the operations described in connection with the C/C **160** (and corresponding distributed component with which the C/C **160** is associated) by directing the C/C **160** to undertake the corresponding functionalities responsive to execution of instructions or algorithms configuring the processor **205** (or processing circuitry **201**) accordingly. As an example, the C/C **160** of the sensors may be configured to detect environmental parameters (e.g., sensor data) and report the sensor data via the first wireless link to the gateway **40** (and ultimately to the app on the user terminal **50** or to storage in the cloud via the network **60**) or to the watering pump **120**. In some cases, the C/C **160** of the sensors may be configured to determine a difference between a prior set of sensor data (e.g., the magnitude of a previous sensor measurement) and the current set of sensor data (e.g., the magnitude of a most recent sensor measurement). The amount of difference may then be used to determine whether or not the sensor will report the current set of sensor data. If the difference is small (e.g., less than a threshold amount) the sensor may not report the new value. However, if the difference is large enough (e.g., larger than the threshold amount), then the sensor may report the new value. As such, the C/C **160** of the sensors may be configured to perform battery conservation techniques relative to reporting of sensor data. The C/C **160** of the sensors may also be configured to otherwise report (or make a determination on whether to report based on the criteria discussed above) sensor data on a given schedule or responsive to certain activities or events. When a trigger event (e.g., temporal or action based trigger) occurs, the C/C **160** of the sensor may make a determination of the current sensor data and decide whether or not to report the sensor data.

The C/C **160** of the watering pump **120** may be configured to receive instructions from the gateway **30** regarding an operational mode of the watering pump **120** as defined by the app, or by locally stored programming. For example, the gateway **40** may receive instructions from the user via the user terminal **50** regarding what operational mode (e.g., controlling on/off cycles of the pump) the user desires the watering pump **120** to operate in. In some example embodiments, the user-selectable operational modes of the watering pump **120** may include, but are not limited to, an intelligent mode, a scheduled mode, or a manual mode. When the intelligent mode is selected by the user, the watering pump **120** may operate independently based on programmed triggers. In some cases, the triggers may be sensor data received from the first or second sensor **140** or **142**. For example, the C/C **160** of the watering pump **120** may be programmed to turn on the watering pump **120** and provide water when sensor data falling within or exceeding certain ranges or thresholds is received. Thus, in some example embodiments, if the sensor data indicates that soil moisture is below a given threshold, the watering pump **120** may be configured to energize the watering pump **120** to enable delivery of water to the sprinklers.

When the scheduled mode is selected by the user, the operator may select a schedule on which the watering pump **120** may operate. For example, the user may select certain times or days in which the watering pump **120** should operate. If the manual mode is selected by the user, the watering pump **120** may only operate upon the user selecting an option on the user terminal **50** that directs the operation of the watering pump **120**. Therefore, the user at any time may decide to water the lawn and may direct the watering pump **120**, via the user terminal **50**, to operate. In some cases, the user may select more than one operational mode at a time. For example, the user may send instructions, via the gateway **40**, to the watering pump **120** regarding a schedule on which the watering pump **120** is to operate. However, in addition to this provided schedule, the user may instruct the watering pump **120** to also simultaneously act in the intelligent mode. For example, the user may define triggers under which the watering pump **120** may operate. These triggers may include, but are not limited to, the soil moisture falling below or exceeding a given threshold. Accordingly, the watering pump **120**, via the C/C **160**, may be configured to operate on a schedule while also operating in response to pre-defined triggers. Even if the user has selected that the watering pump **120** operate under both the intelligent and scheduled mode, the user may select the manual operation mode which causes the watering pump **120** to operate whenever the user desires. The user may select this manual operation mode without affecting the already programmed intelligent and scheduled modes.

Even further, the C/C **160** of the watering pump **120** may be configured to receive instructions from the user (via the gateway **40**) regarding a volume mode of the watering pump **120**. Therefore, the gateway **40** may receive instructions from the user via the user terminal **50** regarding not only what operational mode (e.g., on/off cycle control) the user desires the watering pump **120** to operate in, but what volume mode the watering pump **120** should operate in where the volume mode defines pump speed and output pressure. The volume modes of the watering pump **120** that may be selectable by the user include, but are not limited to, 1) micro drip mode; 2) small amount mode; 3) conservation mode; 4) automatic mode; or 5) garden mode. The micro drip mode, for example, may supply a small amount of water at a gentle drip or trickle pressure. The user may select the micro drip mode for irrigating or watering flowers or vegetation. The small amount mode may be suitable for when only a small area is being irrigating or watered. The conservation mode may ensure that the watering pump **120** is not operational while a shower, washing machine, dish washer, or the like is being operated in the house associated with the parcel to ensure sufficient water pressure is maintained both in the home and at the watering pump **120**. The automatic mode may allow the C/C **160** of the watering pump **120** to determine the appropriate volume of water to be supplied by the watering pump **120** based on the on sensor data received from the first or second sensor **140** or **142**. The garden mode may be selected when a full soaking of the garden, lawn, or flower bed is desired and full pump or line pressure is desired.

In some cases, the volume modes may be selectable based on certain areas of the lawn or parcel. Even further, some of the volume modes may be selectable simultaneously. For example, the user, via the user terminal **50**, may select that the garden mode should be employed on Saturday at 8:00 a.m for zone 1 of the parcel. In conjunction with selecting the garden mode for the applicable time period for zone 1, the user may also select the conservation mode. Therefore, if the washing machine is running at 8:00 a.m. on Saturday morning, the C/C **160** may be configured to delay the operation of the watering pump **120** in garden mode until there is detection that the washing machine has shut-off or until a preset time delay expires. In other cases, the user may be alerted, via the user terminal **50**, that the garden mode was not implemented due the detection of the washing machine being operated. Upon receiving this alert, the user may override the conservation mode and implement the garden mode, or in some cases, the user may select when the garden mode should be rescheduled.

In further example embodiments, the C/C **160** of the watering pump **120** may also receive sensor data, via the level sensor **105**, from the water source **100**. For example, where the water source **100** is a water reservoir/cistern, the water reservoir/cistern may have a level sensor **105** that detects the water levels of the water reservoir/cistern. Based on the detected water levels, the watering pump **120** may be programmed to adjust the volume mode, or aspects of the operational mode, accordingly in order to ensure a sufficient water supply in the reservoir/cistern is maintained. For example, if the user selects that the garden mode should be used for zone 1 every Monday-Friday at 8:00 a.m., the watering pump **120**, based on data received from the level sensor **105** of the water reservoir/cistern, may be able to determine that there will not be a sufficient water supply to perform the programmed schedule. Accordingly, the C/C **160** may be configured to automatically adjust the programmed schedule to adapt to the detected water level. In some cases, the user may be sent an alert or alarm, via the user terminal **50**, of the insufficient water quantity in order for the user to adjust the schedule accordingly. For example, the C/C **160** of the watering pump **120** may determine, based on data received from the level sensor **105**, that the cistern/reservoir only contains 50% of the water required for the operational or volume mode selected by the user. Accordingly, the C/C **160** may automatically modify the operation of the watering pump **120** to supply 50% less water than was going to be supplied under the selected operational or volume mode. However, in other cases, the C/C **160** may be configured to provide an alert to the user that there is insufficient water volume for the watering pump **120** to operate in accordance with the selected operational or volume mode. The user may then be able to select how they wish to modify the programming of the watering pump **120**. For example, the user may be provided options to reduce the volume of water that is scheduled to be supplied by the selected operational or volume mode by 50%, or in some cases, the user may be able to modify the selected operational or volume to fit within the capacity of the detected water level of the cistern/reservoir.

In some example embodiments, the last received instructions regarding the operational or volume mode from the user may be stored locally in the memory **203** of the C/C **160**. Accordingly, if the C/C **160** loses connectivity to the gateway **40**, the C/C **160** may continue to employ the last received instructions regarding the operational or volume mode. In another example embodiment, if the C/C **160** loses connectivity to the gateway **40** or loses connectivity for longer than a predetermined time period, the C/C **160** may be configured to override the last received instructions from the user regarding the selected operational or volume mode and switch to a default setting. In some cases, the default setting may the intelligent operational mode or the automatic volume mode. Therefore, the C/C **160** will determine the appropriate time to water and the appropriate volume of water to be supplied by the watering pump **120** based on sensor data received from the first or second sensor **140** or **142**. In either case, the default settings or the last received instructions (and any programs associated therewith) are stored locally at the C/C **160** so that the watering pump **120** can operate independently of connectivity to the network **60**.

The C/C **160** of the robotic rover **15** may be configured to control the travels and operations of the robotic rover **15**. Moreover, the C/C **160** of the robotic rover **15** may allow the gateway **40** to grant user access to modification of the schedule of operations of the robotic rover **15** and/or to take real-time control over various operations of the robotic rover **15**. In an example embodiment, the app at the user terminal **50** may be employed to coordinate and/or de-conflict programmed water schedules and mowing schedules. Additionally or alternatively, if the operator makes a modification to a operational mode of the watering pump **120** or takes manual control of one or more components, the app at the user terminal **50** may provide alerts to indicate that the proposed changes to the schedule or current operational mode may be problematic, or may prevent the making of such changes. Thus, for example, if the robotic rover **15** is mowing in an area in which a sensor indicates a low soil moisture value that would normally trigger operation of the watering pump **120** via the programming of the watering pump **120**, an alert may be provided to indicate that the robotic rover **15** should have its operations changed, or the operation of the watering pump **120** may be delayed.

In an example embodiment, the electronic deployed components (e.g., components having a P/S **150**) may further include local operator **211** (e.g., a button, knob or other control device) provided at a portion thereof. In some cases, the local operator **211** may be provided to allow local manual setting of one or more characteristics of the watering pump **120**. Thus, for example, the local operator **211** may be used to determine pump output pressure, speed, volume mode, operational mode, and/or the like. The local operator **211** may trigger different functionalities through the programming of the processing circuitry **201** for corresponding different situations and/or actuation methods. For example, some actuation of the local operator **211** may cause the corresponding device to go into a pairing mode. Once in the pairing mode, the device may be detectable by the gateway **40** and/or other devices for a given period of time. The app on the user terminal **50** may be used to detect the device in pairing mode and, once detected, the app may also be used to pair the device to another device (e.g., of the first network—the deployed component network). The gateway **40** and the C/C **160** of the corresponding devices may then be capable of communication with each other on a continuous, event driven, or scheduled basis via the first wireless link. Thus, for example, the first sensor **140** may be configured to provide sensor data to the watering pump **120** (e.g., via the gateway **40**). In some cases, the first sensor **140** may be paired with the watering pump **120** via a setup procedure and communicate thereafter on a schedule or an activity/event driven basis. In some cases, simple replacement or insertion of a battery to power up the device may be an additional or alternative method by which to initiate the pairing mode.

In some cases, a certain defined actuation (or patterns of actuation) of the local operator **211** may result in returning the device to factory settings. As such, contents of the memory **203** may be cleared or otherwise reset to initial settings or conditions. Other functions may also or alternatively be provided. Moreover, some devices may have additional buttons or operable members.

Communication between the gateway **40** and the sensors or the watering pump **120** may occur for pairing purposes and to facilitate the operational activities for which the system **10** is ultimately configured. Thus, for example, the operator may use the app at the user terminal **50** to connect to the gateway **40** and may be provided with one or more control console or interface screens that provide options for interacting with deployed components and/or for programming the deployed components, as described above. In some cases, initial setup of the system may be facilitated by placing individual deployed components (either sequentially or simultaneously) in a pairing mode. The deployed components are then discoverable via the first wireless link and can be added to the first network. Once added to the first network, the deployed components are considered to be assets of the first network that can be interacted with/programmed and/or the like. The deployed components can then be paired with each other and configured for individual and/or cooperative functional performance.

In an example embodiment the watering pump **120** may be paired with other second watering pumps, with the robotic rover **15**, and/or the first sensor **140**. When the watering pump **120** is paired with and connected to the first sensor **140**, the operator may have options provided (e.g., via the app) to select the desired operational or volume mode of the watering pump **120**. In cases where the intelligent operational mode is selected by the user, the watering pump **120** may therefore be instructed regarding the specific stimuli that may be received from the first sensor **140** to trigger operation of the watering pump **120**. However, as described above, the watering pump **120** may be provided with (e.g., in the memory **203**) a schedule or a trigger which causes the watering pump **120** to "ping" or otherwise reach out to the first sensor **140** to initiate communication to receive sensor data. Based on the sensor data received (e.g., if certain threshold parameters are reached or not), the watering pump **120** may be turned on or off.

When the watering pump **120** is paired with and connected to the robotic rover **15**, automatic coordination of schedules may be accomplished at least relative to ensuring that mowing and watering are not conducted in the same area at the same time. The app on the user terminal **50** may ensure that scheduling of mowing during watering (or vice versa) is not possible. However, given that the operator can take control of the watering pump **120** and/or the robotic rover **15** to initiate operations, the app on the user terminal **50** may further prevent any attempts to initiate operations of watering pumps or the robotic rover **15** in real-time when the other is also operating in the same area.

When the watering pump **120** is paired with and connected to the other watering pumps, watering schedules or operations can be coordinated to manage or prevent under-pressure situations or excessive draining of the water source **100**. For example, if the watering pumps are connected to the same water source, it may be possible for water supply to be insufficient to effectively charge both the water line **110** and the second water line at the same time. Thus, by allowing multiple watering pumps to be in communication with each other, operations of one may be communicated to the other (e.g., via the gateway **40**) so that the water source **100** and its supply of water can be managed effectively.

Therefore, the deployed components of various example embodiments may be adaptive to various conditions or situations. Moreover, the adaptive nature of the deployed components may be provided, as described above, as a programmable feature, where the operator can use the user terminal **50** to program modes, adjustable parameters, relationships, or responses. In the context of some examples, the programmable features should be understood to be remotely programmable (i.e., programmable from the app and/or the user terminal **50** remote from the component being programmed) via the gateway **40**. In other examples, the adaptive nature of the deployed components may be provided as a default feature. Thus, the adaptive capabilities of the deployed components may either be dependent upon connectivity (e.g., connectivity dependent) for remote programming, or may be connectivity independent (e.g., default programming that exists or is instituted when there is no connectivity or responsive to a loss of connectivity.

In some embodiments, battery power levels may be communicated to the gateway **40** and signal strength values relating to communication with the sensors and/or watering pumps may also be determined at the gateway **40**. This information (along with sensor data) may be provided to the app at the user terminal **50** to alert the operator when battery power is low, or signal strengths are low. Battery replacement and/or sensor repositioning may then be undertaken to improve the situation. As mentioned above, in some cases, the sensor may also adaptively respond to its surroundings to trigger reports. In an example embodiment, the watering pump **120** may attempt to ping the first sensor **140** via the gateway **40** to trigger a report of sensor data. However, the first sensor **140** may be configured (e.g., via the C/C **160**) to determine the amount of change in the requested parameter before deciding whether to respond to the ping. In some embodiments, a change of at least a specific amount or percentage (e.g., 5%) may be required before the first sensor **140** will report sensor data via wireless transmission. Since wireless transmission consumes more power than internal operation (e.g., to determine the amount of change and current sensor data), by saving several transmission cycles when there is little data change, battery life can be substantially extended. When a ping is sent and no response is received, the last value received may be substituted and communicated to the operator (e.g., via the app).

The operator can turn on/off or wake up the watering pumps and/or sensors by sending instructions via the user terminal **50** through the gateway **40**. For example, the wake up message may be used to see if the devices are still reacting and active, or to request specific data from or initiate actions at such components in real time. Moreover, in some cases, the operator can send a wakeup, or setup signal to have the corresponding device beacon for at least a predetermined amount of time (e.g., three minutes). During this time, the devices may be positioned and the operator may check the app to see what signal strength is detected by the gateway **40**. The operator can therefore position the devices in real time and make sure that the position in which a device is currently located is a good location from the perspective of its ability to communicate with the gateway **40**.

In some embodiments, one or more of the deployed components may further include frost warning capability. In particular, since the watering pumps typically may have some residual water therein, it should be appreciated that freezing of water in the body of the watering pumps may be destructive to the watering pumps. Accordingly, the C/C **160** of one or more components (especially the watering pumps) may be configured to identify situations where there is a potential for frost that may damage the watering pumps or other watering equipment **20**. In some embodiments, if the temperature reaches a predetermined threshold distance from the freezing point (e.g., 5 degrees C., or 10 degrees F.), an alert may be issued (e.g., through the app at the user terminal **50**) to warn the operator that the watering pump **120** (and/or sensors) should be brought in to avoid damage. The predetermined threshold may be a factory setting, or may be set by the operator. However, in either case, the ability to identify a present temperature condition to alert the operator of a possible frost event is another example of how the deployed components may be configured (by operator program or by default) to be adaptive relative to their surroundings and/or circumstances.

In further example embodiments, the water source **100** (or in some cases the watering pump **120**) may include a heating element **101** that is configured to heat the water to a temperature programmed by the user. For example, in cases where a frost event is detected, the heating element **101** may heat the water in order to avoid freezing of the components of the watering pump **120** or water source **100**. Moreover, for flowers or vegetation that requires water at a certain temperature in order to enhance growing conditions, the heating element **101** may be configured to heat the water to the desired temperature programmed by the user.

Another example of the adaptability of the deployed components relates to the inability to connect to the first network or a loss of connection to the first network. For example, although the last received operation or volume mode could be maintained in the cloud, on the user terminal **50**, or elsewhere, in some cases, the current operational or volume mode (or at least a portion thereof) may be stored locally at the watering pumps. For example, the memory **203** may be configured to record at least the last water schedule information employed. Thus, if power is lost at the gateway **40** or at another system component that thereby renders connectivity impossible, the watering pump **120** may store at least the information indicative of its respective last watering schedules. Thus, for example, if the watering pump **120** operated at **1300** and shut down at **1305**, if no connection the network **60** for determining the watering schedule can be achieved, or if connectivity is lost, the watering pump **120** will continue to water on the previously provided operational and volume mode. In some cases, if the C/C **160** of the watering pump **120** determines that connectivity has been lost for longer than a pre-determined time interval, the C/C **160** may be configured to override the previously provided operational and volume mode to operate on the default setting, as described above.

In further example embodiments, C/C **160** of the deployed components may able to determine the usage and runtime of each of the deployed components. For example, the C/C **160** may be configured to monitor and calculate the runtime of and the water usage by the watering pump **120**. Therefore, the C/C **160** may be able to determine the volume of water used over a specific time interval, such as an hour, day, week, month, or plurality of months (i.e., seasons). These calculations may be provided to the user via the user terminal **50**. Based on the calculations, the C/C **160** may determine an average runtime and usage of the watering pump **120** over a pre-determined time interval. Using these calculated average runtime and usage values, the C/C **160** may be configured to monitor any further usage and runtime of the watering pump **120** runtime and usage. If the runtime or usage exceeds the average runtime and usage values, the C/C **160** may be configured to send an alert, via the gateway **40**, to the user terminal **50** to indicate the status detection of the abnormal condition.

An even further example of the adaptability of the deployed components relates to the ability of the C/C of the deployed components to determine the recommended maintenance interval for the deployed components. For example, using the above calculated average runtime and usage of the watering pump **120** over a predetermined time period, the C/C **160** of the watering pump **120** may be able to calculate the recommended maintenance interval of the watering pump **120**. This recommended maintenance interval may be displayed on the user terminal. In some example embodiments, the user may be able to override this recommended maintenance interval. The user may be able to select how he or she wants to calculate the maintenance interval (i.e., after a certain time period or certain calculated usage amount). In that case, the C/C **160** may be configured to alert the user when the time period has passed or when the specified usage amount occurs. Even further, the user may be able to input when the last maintenance was performed on the watering pump **120**. By inputting the last maintenance performed, the C/C **160** may be configured reset the maintenance interval and recalculate in accordance with the above.

In some example embodiments, the C/C **160** of the deployed components may be even further configured to send messages to the user that operation of the deployed component has started. In other cases, the C/C **160** may be configured to send messages if the deployed component fails during operation or if an error occurs during operation. For example, if the C/C **160** detects that the water pressure drops or the flow rate increases drastically, the C/C **160** may be configured to determine that the hose has exploded for example. In the event of such an event, an error message or alert would be sent to the user via the user terminal **50**.

If a failure or error occurs during the operation of the deployed component, the user terminal **50** may have an option for the user to send feedback to the manufacturer or supplier of the error or failure. In even further example embodiments, the user terminal **50** may be configured to allow the manufacturer or supplier to have remote access of the deployable component in response to receiving a request from a user or in response to receiving feedback regarding the failure or error of the deployable component.

In one example embodiment, the C/C **160** of the watering pump **120** in particular may be even further configured to receive data from a pump sensor assembly **155** (see FIG. **2**) of the watering pump **120**. The data received from the pump sensor assembly **155** may depend on the type of sensor employed by the watering pump **120**; however, the data may include environmental and operational parameters. The environmental parameters may include water temperature, water quality, pH, or chalk or mineral or fertilizer content of water received into the watering pump **120**. The operational parameters may include, but are not limited to, flow rate, water volume, and pump runtime. The data detected by the pump sensor assembly **155** may be available to the user via the user terminal **50**. In some cases, the user may have selected thresholds or ranges regarding the pump sensor assembly data. For example, the user may have inputted, via the user terminal **50**, that the fertilizer content of the water should be within a certain range. Based on this input by the user, the C/C **160** may be configured to receive data from the pump sensor assembly **155** regarding the detected fertilizer content of the water. If the fertilizer content is above or below the threshold set by the user, the C/C **160** may be configured to automatically adjust the fertilizer provided in the water (as described in more detail below) or to alert the user so the user can adjust the fertilizer accordingly. For example, the water source **100** may include a fertilizer pump **103** (see FIG. **2**) for dispensing fertilizer into the water. Therefore, if the detected fertilizer content of the water is above or below the threshold set by the user, the C/C **160** may be configured to direct the fertilizer pump **103** of the water source **100** to modify its dispensing of fertilizer accordingly.

In some example embodiments, the C/C **160** of the watering pump **120** may be even further configured to detect indicia of volume requirements for filling watering containers, such as a watering can. When the watering can is within the predefined area of the watering pump **120**, the C/C **160** may be configured to read the indicia (e.g., an RFID tag or other coded information) from the watering can regarding the amount of water that should be dispensed into the watering can. For example, if the watering can is programmed to hold two gallons of water, the C/C **160** may receive instructions to dispense two gallons of water into the watering can. However, in some cases, the watering can may not be completely empty and just needs to be topped up. Accordingly, the watering can may include a level sensor that detects and measures the level or quantity of water in the watering can. This measured level or quantity of water may be read by the C/C **160** of the watering pump **120**. Based on the reading, the C/C **160** determine that the watering only needs to receive one gallon in order to fill the watering can.

The watering pump **120** described above may take different physical forms. However, an example structure for embodying a watering pump **120** may be a reciprocating or rotary pump. Thus, for example, the watering pump **120** may include a centrifugal pump having an impeller. The watering pump **120** may include a housing body and a first tap adapter. In some cases, the first tap adapter may be configured to interface with a spigot or tap of a pressurized water system (e.g., water source **100**). In other example embodiments, the watering pump **120** may also include a second tap adapter which may be configured to interface with a spigot or tap of a water container system. However, in further example embodiments where the watering pump **120** includes both a first tap adapter and a second tap adapter, the first tap adapter may be configured to interface with a fresh water source, and the second tap adapter may be configured to interface with water having a fertilizer additive (as described below). In some cases, a sprinkler assembly may be integrated into the housing body **200** of the watering pump **120**. This sprinkler assembly may be operable in a similar manner as described herein. However, other pump structures can also be employed.

In some cases, the watering pump **120** may also include a pump sensor assembly **155**, as discussed above. The pump sensor assembly **155** may include sensors for detecting and measuring both environmental and operational factors. The environmental factors may include, but are not limited to, any of water temperature, pH, mineral content, total dissolved solids, or chalk content sensor. The operational factors may include, but are not limited to, any of flow rate, water volume, or pump runtime.

In some example embodiments, the watering pump **120** may also include a filter for removing some of the solids or minerals from the water. In some cases, the filter may include a filter sensor. The filter sensor may be configured to detect the status of the filter. For example, if the filter is nearly clogged, the sensor may be configured to detect the clogged condition

As has been noted above, the deployed components (e.g. the watering pump **120**) may be largely controlled by the user via the user terminal **50**. As mentioned above, the user terminal **50** could be a mobile device (e.g., a smartphone) or a fixed terminal (e.g., a PC). However, the user terminal **50** could also be other devices such as a tablet, laptop and/or the like. In any case, the user terminal **50** may be configured to provide a simple and intuitive interface for enabling the operator to control operation of the system **10**. FIG. **4** illustrates a block diagram of some components of the user terminal **50** that may configure the user terminal to provide the app for control of the system **10**.

As shown in FIG. **4**, the user terminal **50** may include processing circuitry **310**, a processor **312**, memory **314** and device interface **320** that may be similar in form and/or function to the processing circuitry **201**, processor **205**, memory **203**, and device interface **207** described above. Specific structures, forms and scales of such components may differ. However, the general capabilities may be similar so these components will not be described in detail again in detail. Instead, it should be appreciated that except for changes in specific configuration, content and structure, these components are generally similar. As shown in FIG. **4**, the user terminal **50** may further include a user interface **330** and an operation manager **340**.

The user interface **330** (if implemented) may be in communication with the processing circuitry **310** to receive an indication of a user input at the user interface **330** and/or to provide an audible, visual, mechanical or other output to the user. As such, the user interface **330** may include, for example, a display (e.g., a touch screen display), one or more buttons or keys (e.g., function buttons or a keyboard), and/or other input/output mechanisms (e.g., microphone, mouse, speakers, cursor, joystick, lights and/or the like). The user interface **330** may be configured to provide alerts, warnings and/or notifications to the user or operator responsive to various trigger conditions being detected (e.g., via the sensor equipment **30** or other components). For example, the watering pump **120** may include a sensor to detect when damage, tampering, or theft of the watering pump **120** is detected. System malfunctions, damage or tampering with equipment, equipment theft and other component related stimuli may also be defined as triggers for generation of the alerts, warnings and/or notifications. In some cases, the user interface **330** may be configured to generate such alerts, warnings and/or notifications in response to the runtime or usage of the watering pump **120** being out of the recommended ranges, or in response to system components having schedule or operational conflicts. Notifications may also be provided regarding general status, current conditions and/or the like. The alerts, warnings and/or notifications may be generated via light, sound, visual display, or other devices that may be connected to or part of the operation manager **340**. In some cases, the notifications may be provided by text message or email. Even further, the user interface **330** may be configured to enable the user to delegate operation of the system to second user for a predetermined period of time. For example, if the user is going on vacation or will be out of town, the second user may be given permission to control the system via the second user's user interface.

In an example embodiment, the processing circuitry **310** may be configured to perform data processing, control function execution and/or other processing and management services according to an example embodiment of the present invention. As such, it may be appreciated that the processing circuitry **310** may be configured to control or be embodied as the operation manager **340**. The operation manager **340** may be configured to receive sensor information from the sensor equipment **30** and/or the watering equipment **20** and make decisions regarding information to be provided to the owner/operator and/or instructions to be provided to the sensor equipment **30** and/or the watering equipment **20**. The processing circuitry **310** may, in some cases, process the condition information received from the sensor equipment **30** and compare the condition information to growing condition parameters that are stored in the memory **314** for a given zone.

In an exemplary embodiment, the memory **314** may be configured to store information, data, applications, instructions or the like for enabling the operation manager **340** to carry out various functions in accordance with exemplary embodiments of the present invention. For example, the memory **314** could be configured to buffer input data for processing by the processor **312**. Additionally or alternatively, the memory **314** could be configured to store instructions for execution by the processor **312**. As yet another alternative, the memory **314** may include one or more databases that may store a variety of data sets responsive to input from the sensor network. Among the contents of the memory **314**, applications may be stored for execution by the processor **312** in order to carry out the functionality associated with each respective application. In some cases, the applications may include applications for generation of control consoles for providing options for control of the system. In some cases, the applications may also or alternatively include applications for receiving information regarding component activity/status, environmental parameters, operational or volume mode, device pairing, and/or the like to allow the operation manager **340** to define responses to the information (e.g., based on predefined programming or user input). The information/parameters may be entered by the operator, received from deployed components, or may be extracted or retrieved from databases or sources accessible via the internet based on entry of an identity of the plant vegetation in a given zone. The operation manager **340** may therefore not only provide interface mechanisms for control of the operation of the watering pump **120**, the operation manager **340** may be embodied at the network **60**. In instances where the operation manager **340** is embodied at the network, the operation manager **340** may be configured to extract information/parameters from multiple users over a predefined area such as a state or country. The information/parameters may include data extracted from the deployed components of the multiple users. For example, based on the data extracted from the deployed components of several users, a water shortage may be detected in the user's area. Therefore, if the user had selected to be made aware of water shortages in his or her area, the operation manager **340** may be configured to not allow the user to select programming options that would require a large volume of water.

FIG. **5** illustrates a block diagram of one example of operations that may be facilitated by the operation manager **340** in accordance with an example embodiment. As shown in FIG. **5**, the watering pump may initially be off, but the user terminal **50** may present a control console (or series of control consoles) via which the operator can provide instructions to initiate the operations of FIG. **5**. An instruction may be provided at operation **400** to turn on the watering pump **120** (i.e., via selecting manual mode). In response, a signal regarding the volume mode may be received at operation **401**. Once, the pump is on and volume mode signal is received, a determination may then be made at operation **403**, as whether there is sufficient water capacity in order to enact the volume mode. If there is not, the user may be prompted to change the volume mode selection that fits within the detected water capacity. Once a selection is made that ensures sufficient water capacity, a determination made then be made, at operation **402**, as to whether the robotic rover **15** is active in the area (or at all). If the robotic rover **15** is active, a warning may be issued at the user interface **330** of the user terminal **50** at operation **404**. The operator may then determine whether to allow operation of the watering pump **120** or not at operation **406**. If the operator decides not to operate the watering pump **120**, flow returns to the initial state. If the operator decides to allow operation of the watering pump **120** anyway (e.g., overriding or disregarding the warning), the operator may then be asked to enter a time duration for operation of the watering pump **120** at operation **408**. Of note, the operator may also have the option to cancel to return to the initial state at this time instead of entering the time duration.

Assuming the time duration is entered, an activation signal may be issued from the user terminal **50** to the watering pump **120** to direct operation thereof at operation **410**. The watering pump **120** may then remain in an operating state until the time duration expires, at which time the watering pump **120** may turn off and flow returns to the initial state. However, the operator may also insert instructions to manually turn off the watering pump at operation **412**. A determination may then be made as to whether the manual turning off is before or overlaps with a scheduled start time at operation **414**. If this manual turning off (off schedule) defines an end time that is before the scheduled next start time, the schedule may be maintained at operation **416** and the watering pump **120** may turn off at operation **420** so that flow may return to the initial state to be ready for operation again in accordance with the schedule. However, if the manual shutoff corresponds with a scheduled start time, then the schedule may be skipped at operation **418** and the watering pump **120** may turn off at operation **420** so that flow may return to the initial state to be ready for operation again when the next scheduled operating time arrives. Meanwhile, from the initial state, if the scheduled operating time is reached at operation **422**, the watering pump **120** may operate at operation **410** at the corresponding time, and responsive to time expiring at operation **424**, the watering pump **120** may shutoff. Likewise, from the initial state, if operation is triggered by sensor data at operation **426**, the watering pump **120** may operate at operation **410** and then shutoff after a predetermined period of time expires at operation **424** or when the condition clears at operation **428**. Of note, the operator may also manually operate or shutoff the watering pump **120** by operating a local button or knob at the watering pump **120**. If manual (local) operation is performed, the operations described above may still be performed and the times for remaining opening (or a next programmed opening) may again be governed by the schedule information input into the operation manager **340**.

In some cases, the watering pump **120** may include a limited user interface in the form of a main button (or knob) provided on a front panel thereof, and a light assembly. The light assembly may include three LEDs the LEDs may be capable of expressing red, green and yellow colors in a solid or flashing manner. The LEDs may be useful for providing status information associated with attempts to pair the watering pump with another device, battery status, pump status, and/or the like.

In an example embodiment, the user interface **330** of the user terminal **50** may be employed initially to provide control console options for adding devices to the first network so that they are discovered by the gateway **40** and are recognized by the operation manager **340**. When the pairing mode is initiated (e.g., by battery insertion into a deployed component, or by pressing the reset button, or by selection of an option on the user terminal **50**) for the watering pump **120**, the watering pump **120** may be discovered by the gateway **40** and the gateway **40** may communicate the identity of the discovered watering pump **120** to the user operation manager **340** so that information indicative of the discovered watering pump **120** can be displayed at the user interface **330**. A determination is then made as to whether pairing is possible. The user interface **330** of the user terminal **50** may also or alternatively provide an indication of detection of the watering pump **120**. If the gateway **40** is unable to find the watering pump **120**, a LED lighting output may be generated.

Once the gateway **40** has discovered and is able to be paired with the watering pump, the LED lighting outputs during the pairing mode may be converted to a signal strength indicator. Again similar indications could also be provided at the user terminal **50**.

FIG. **6**, which includes FIGS. **6**A-**6**D, illustrates some examples of interface screens or control consoles that may be provided by the operation manager **340** in some embodiments. FIG. **8**A illustrates a basic start screen showing a home page **600** for the app. The app may display a general watering pump data section **610**, which may display runtime and usage data associated with the watering pump **120**. In some cases, the app may also display device status information **620**, which may show each device of the first network along with corresponding status information such as, for example, battery status, operational modes, operational status, and/or the like. In an example embodiment, an option may also be provided for adding new devices in box **630**. In some cases, an option may be provided for delegated operation of the system to a second user in box **640**.

In some cases, by selecting the watering pump data section **610** (or an individual sensor), various individual or collective screens showing the status of each sensor may be provided. FIG. **6**B illustrates an example pump status screen

650 that may be accessed responsive to selecting the pump data section 610. In some embodiments, the pump status screen 650 may include a current pump data section 660 that may display current pump data. A historical pump data section 670 may also be provided to show past data over a given period of time (that may be user selectable). A settings adjustment option 680 may also be provided to allow the operator to select various pump settings. The pump settings may relate to selecting operational or volume modes, pairing activity, signal strength, battery levels, and/or the like.

FIG. 6C illustrates an example device status screen 700 that may be accessed responsive to selecting the current pump data 660. In some embodiments, when selecting the current pump data, a graphical representation of the current day's water usage will appear at section 720. At section 740, the user may select the statistics option to get a detailed breakdown of the water usage associated with that day.

FIG. 6D illustrates an example device status screen 750 that may be accessed responsive to selecting the historical pump data 670. In some embodiments, when selecting the historical pump data, a graphical representation of the last week's water usage, for example, will appear at section 770. At section 790, the user may select the statistics option to get a detailed breakdown of the water usage associated with that week. At select 800, the user may select the data range option to define the exact range over which the historical pump data should be gathered. Therefore, if the user wants to see the last month's data usage, the user may adjust the date range accordingly.

Embodiments of the present invention may therefore be practiced using one or more apparatuses such as the ones depicted in FIGS. 1-6. As such, a system of an example embodiment may include sensor equipment including one or more sensors disposed on a parcel of land, watering equipment disposed on the parcel and configured to selectively apply water to the parcel, and a gateway configured to provide for communication with the sensor equipment and the watering equipment. The watering equipment may include a watering pump, the watering pump being operably coupled to a water source and a water line to alternately couple the water source to and isolate the water source from the water line. In an example embodiment, the watering pump may include two water inlets (e.g., an inlet for fresh water and an inlet for reservoir water or an inlet for normal water and an inlet for water with fertilizer). The watering pump may further include a pump sensor assembly configured to detect environmental and operational parameters and processing circuitry configured to operate the pump based on detected environmental and operational parameters. In some embodiments, the watering pump may be configured to turn on or off with respect to predetermined time intervals. Alternatively or additionally, the watering pump may have sensor to recognize possible theft or tampering. Alternatively or additionally, the watering pump may be configured to read a code or chip on a watering can that enables the watering pump to deliver a predefined amount of water into the watering can. In some embodiments, the watering pump may have a housing that includes a water sprinkler (e.g., a countour sprinkler).

In an example embodiment, the gateway interfaces between a first network including at least the watering equipment and the sensor equipment and a second network via which a user is enabled to wirelessly communicate with the gateway via the user terminal. In further example embodiments, the operational parameters may include any one of water volume, pump runtime, or flow rate. By detecting water volume, pump runtime, or flow rate, events such as an exploded hose may be recognized. The environment parameters may include any one of water temperature, pH, chalk content, mineral content, or total dissolved solids. By detecting the total dissolved solids of the water, chalk content, or mineral content, the cloudiness of the water may also be detected. Alternatively or additionally, by detecting water temperature, the watering pump may be enabled to alert the user of freezing conditions in order to prevent damage to the watering pump.

The watering pump may further include a filter for removing solids, chalk, or minerals from the water. The filter may include a sensor for detecting the clogged status of the filter. Alternatively or additionally, the watering pump may further include a heating element, where in response to the temperature of the water received from the water source being below a predetermined threshold, the heating element being configured to heat the water to a predetermined temperature. In other example embodiments, the water source may include a heating element, where in response to the temperature of the water being below a predetermined threshold, the heating element is configured to heat the water to a predetermined temperature.

The processing circuitry may be further configured to determine the recommended maintenance interval of the watering pump. Alternatively or additionally, the maintenance interval may be based on a predefined time period, water volume, or pump runtime. In other cases, the maintenance interval may be a calculated interval based on last maintenance inputted by a user. In further example embodiments, the maintenance interval may be based on a time interval or water volume inputted by the first user. The processing circuitry may be further configured to detect a loss of connectivity to the gateway or the sensor and the time associated therewith. In the event of a loss of connectivity, the processing circuitry of the watering pump may be configured to store all operational and volume modes or any other information received from the user via the user terminal.

In some cases, the water source may include a level sensor for detecting the volume of water in the water source. The water source may be a cistern/reservoir, and the volume of water in the cistern/reservoir detected by the level sensor may be used to calculate how much water may be used by the watering pump 120 in implementing the operational and volume modes. Even further, the volume of water detected by the level sensor may used to adopt efficient water schedules in respect to the amount of water in the cistern/reservoir. Alternatively or additionally, the water source may include a fertilizer pump enabling the user to dispense a desired amount of fertilizer into the water. Alternatively or additionally, the watering pump may include a knob that allows for dispensing a predefined amount of water from the water source. Alternatively or additionally, the watering pump may pressurize the water of the water source, and the watering pump may have motor that can be altered in speed.

The processing circuitry may be further configured to receive operational mode instructions from the gateway; determine, based on the operational mode instructions received from the gateway, the operational mode of the watering pump; and direct the watering pump to operate in accordance with the operational mode. In even further example embodiments, the processing circuitry may be further configured to receive volume mode instructions from the gateway; receive water source sensor data indicating the volume of water in the water source; determine, based on the volume mode instructions from the gateway and the water source sensor data, if the watering pump is operational in accordance with the volume mode instructions received; and direct the watering pump to operate in accordance with the volume mode instructions if the processing circuitry determines the watering pump is operational. In some example embodiments, the user terminal may include an interface displaying the status of the watering pump. In further example embodiments, the user terminal may include an interface for displaying the usage of water by the watering pump.

Many modifications and other embodiments of the inventions set forth herein will come to mind to one skilled in the art to which these inventions pertain having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the inventions are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Moreover, although the foregoing descriptions and the associated drawings describe exemplary embodiments in the context of certain exemplary combinations of elements and/or functions, it should be appreciated that different combinations of elements and/or functions may be provided by alternative embodiments without departing from the scope of the appended claims. In this regard, for example, different combinations of elements and/or functions than those explicitly described above are also contemplated as may be set forth in some of the appended claims. In cases where advantages, benefits or solutions to problems are described herein, it should be appreciated that such advantages, benefits and/or solutions may be applicable to some example embodiments, but not necessarily all example embodiments. Thus, any advantages, benefits or solutions described herein should not be thought of as being critical, required or essential to all embodiments or to that which is claimed herein. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

That which is claimed:

1. A system comprising:
- sensor equipment comprising one or more sensors disposed on a parcel of land;
- watering equipment disposed on the parcel of land, the watering equipment being configured to selectively apply water to the parcel;
- a user terminal comprising a user interface; and
- a gateway configured to communicate with the sensor equipment, the watering equipment, and the user terminal, wherein the user terminal is a mobile terminal configured to communicate wirelessly as part of a communication link with the watering equipment via the gateway;
- wherein the watering equipment comprises a watering pump, the watering pump being operably coupled to a water source and a water line to alternately couple the water source to, and isolate the water source from, the water line;
- wherein the watering pump comprises:
  - a pump sensor assembly configured to detect environmental and operational parameters, and
  - communication circuitry comprising an antenna, the communication circuitry being configured to:
    - communicate with the gateway,
    - monitor and calculate a runtime of the watering pump,
    - monitor and calculate water usage by the watering pump, and
    - communicate, to the user terminal, runtime information based on the runtime of the watering pump and water usage information based on the water usage by the watering pump;
- wherein the user terminal is configured to:
  - receive the runtime information and water usage information, and
  - present the runtime information and water usage information to a user via the user interface.

2. The system of claim **1**, wherein the communication circuitry is further configured to determine a volume of water used over a time interval.

3. The system of claim **2**, wherein the time interval is an hour, a day, a week, a month, or a plurality of months.

4. The system of claim **1**, wherein the communication circuitry is further configured to determine an average runtime and the water usage of the watering pump over a pre-determined time interval.

5. The system of claim **1**,
- wherein the user interface of the user terminal is configured to:
  - display a status of the watering pump; and
  - provide a plurality of interface screens comprising a device status screen, the device status screen comprising a section at which graphical representation of a current day's water usage appears.

6. The system of claim **1**, wherein the gateway is configured to connect between a first network comprising the watering equipment and the sensor equipment, and a second network comprising the user terminal.

7. The system of claim **1**, wherein the communication circuitry is further configured to:
- detect an abnormal condition indicated by the runtime of the water pump exceeding an average runtime of the water pump; and
- transmit, to the user terminal via the gateway, an alert indicating the abnormal condition in response to detecting the abnormal condition.

8. The system of claim **1**, wherein the communication circuitry is further configured to:
- detect an abnormal condition indicated by the water usage of the water pump exceeding an average water usage of the water pump; and
- transmit, to the user terminal via the gateway, an alert indicating the abnormal condition in response to detecting the abnormal condition.

9. The system of claim **1**, wherein the communication circuitry is further configured to:
- detect an abnormal condition of the water pump; and
- transmit, to the user terminal via the gateway, an alert indicating the abnormal condition in response to detecting the abnormal condition.

10. The system of claim **1**, wherein the communication circuitry is further configured to determine usage and runtimes for a plurality of deployed components of the watering equipment including the water pump.

11. The system of claim **1**, wherein the watering equipment comprises a plurality of sprinklers and the sensor equipment comprises a plurality of sensors;
- wherein location-based sprinkler-sensor associations are defined and indicated on the user interface of the user terminal, each location-based sprinkler-sensor association being based on a location of each sprinkler and a location of each sensor;
- wherein the user terminal is configured to:

correlate data received from the sensors to actions of the watering pump and to the sprinklers based on the location-based sprinkler-sensor associations; and

control operation of the watering pump based on the correlation of data received from the sensors to the sprinklers based on the location-based sprinkler-sensor associations.

12. A watering pump comprising:

a pump sensor assembly configured to detect environmental and operational parameters; and

communication circuitry comprising an antenna, the communication circuitry being configured to:

communicate with a gateway that is configured to communicate with the watering pump and water sensor equipment and also communicate with a user terminal that is configured to communicate wirelessly, the user terminal being a mobile terminal,

monitor and calculate a runtime of the water pump,

monitor and calculate a water usage by the watering pump, and

communicate, to the user terminal for presentation to a user via a user interface of the user terminal, runtime information based on the runtime of the watering pump and water usage information based on the water usage by the watering pump;

wherein the watering pump is configured to be operably coupled to a water source and a water line to alternately couple the water source to, and isolate the water source from, the water line.

13. The watering pump of claim **12**, wherein the communication circuitry is further configured to determine a volume of water used over a specific time interval.

14. The watering pump of claim **13**, wherein the specific time interval is an hour, a day, a week, a month, or a plurality of months.

15. The watering pump of claim **12**, wherein the communication circuitry is further configured to determine an average runtime and the water usage of the watering pump over a pre-determined time interval.

16. The watering pump of claim **12**, wherein the communication circuitry is further configured to provide the user terminal with the runtime information as calculations of the runtime of the water pump and the water usage information as calculations of the water usage of the watering pump.

17. The watering pump of claim **12**,

wherein the user interface of the user terminal is configured to:

display a status of the watering pump; and

provide a plurality of interface screens comprising a device status screen, the device status screen comprising a first section at which graphical representation of a current day's water usage appears.

18. The watering pump of claim **17**, wherein the device status screen comprises a second section configured to allow a user to select a statistics option to request and obtain information indicating the water usage associated with a selected day.

19. The watering pump of **12**, wherein the plurality of interface screens comprises a pump status screen and a device status screen;

wherein the pump status screen comprises a historical pump data section configured to show past data over a given period of time; and

wherein the device status screen is configured to be accessed responsive to selecting historical pump data in the historical pump data section, the device status screen comprising a first section configured to show a graphical representation of water usage for last week.

20. The watering pump of claim **19**, wherein the device status screen further comprises a second section configured to allow a user to select a statistics option to request and obtain information indicating the water usage associated with a selected week.

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